Stoller
Hanford Office

DOE-EM/GJ873-2005

299-E17-02 (A5879)
Log Data Report

Borehole Information:

Borehole: 299-E17-02 (A5879)			Site: 216-A-27 Crib		
Coordinates (WA St Plane)		GWL[1] (ft): None		GWL Date: None	
North (m)	East (m)	Drill Date	Top of Casing Elevation (ft)	Total Depth (ft)	Type
135389.809	575221.115	04/60	719.73	406	Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	1.0	6 5/8	6 1/8	1/4	1.0	280
Welded steel	1.1	8 5/8	8	unknown	1.1	400

Borehole Notes:

The logging engineer measured the 6-in. casing and stickup using a steel tape. Measurements were rounded to the nearest 1/16 in. The 8-in. casing could not be measured. Casing depths are derived from *Hanford Wells* (Chamness and Merz 1993), which also reports grout in the annular space between the 6-in. and 8-in casings. The 6- and 8-in. casings have been cut above the ground surface by an undetermined amount. Therefore, the logging reference point (i.e., top of casing) elevation will be less than reported in the above table.

This borehole was logged to a depth of 110 ft to support well decommissioning. The remainder of the borehole was not logged because of decommissioning activities; however, historical log data indicate contamination exists near the ground water level at approximately 313 ft.

Logging Equipment Information:

Logging System:	Gamma 1E		Type: SGLS (70%) SN: 34TP40587A
Calibration Date:	10/04	Calibration Reference:	DOE-EM/GJ772-2004
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 1C		Type: HRLS (planar) SN: 39A314
Calibration Date:	05/04	Calibration Reference:	DOE-EM/GJ713-2004
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2 Repeat			
Date	04/01/05	04/01/05			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	110.0	21.0			
Finish Depth (ft)	2.0	10.0			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A[2]	N/A			
Pre-Verification	AE047CAB	AE047CAB			
Start File	AE047000	AE047109			
Finish File	AE047108	AE047120			
Post-Verification	AE047CAA	AE047CAA			
Depth Return Error (in.)	0	0			
Comments	No fine gain adjustment.	No fine gain adjustment.			

High Rate Logging System (HRLS) Log Run Information:

Log Run	1	2 Repeat			
Date	04/04/05	04/04/05			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	40.0	35.0			
Finish Depth (ft)	31.0	32.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	AC124CAB	AC124CAB			
Start File	AC124000	AC124010			
Finish File	AC124009	AC124013			
Post-Verification	AC124CAA	AC124CAA			
Depth Return Error (in.)	N/A	0			
Comments	No fine gain adjustment.	No fine gain adjustment.			

Logging Operation Notes:

Logging was conducted with a centralizer on the sonde. Logging data acquisition is referenced to the top of casing. Repeat sections were collected in this borehole to evaluate system performance. Before logging, the borehole was swabbed and no contamination was detected.

Analysis Notes:

Analyst:	Henwood	**Date:**	04/07/05	**Reference:**	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for the logging systems were performed before and after each day's data acquisition. The acceptance criteria were met.

A combined casing correction for 0.602-in.-thick casing (0.28+0.322 for the 6- and 8-in. casings) was applied to the log data.

SGLS and HRLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL worksheet templates identified as G1EOct04.xls and G1CMay04.xls for the SGLS and HRLS, respectively, using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied to the SGLS data when it exceeds 6.4 percent and where the HRLS exceeds 10.8 percent. No correction for water was necessary.

HRLS data are normally substituted where the SGLS dead time exceeds 40 percent. However, the SGLS concentrations, determined in the depth intervals where dead times ranged from 40-56 percent data, indicated less error than the HRLS. Therefore, only SGLS data are utilized for this borehole.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{137}Cs, ^{60}Co, and ^{154}Eu) detected in the borehole, naturally occurring radionuclides (^{40}K, ^{238}U, ^{232}Th [KUT]), a combination of man-made, KUT, and dead time, and total gamma plotted with dead time. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. Repeat log sections are also included. A plot of historical total gamma data acquired in 1963, 1970, and 1976 and the current SGLS total gamma data is provided.

Results and Interpretations:

^{137}Cs was detected between approximately 21 and 61 ft and at a few sporadic location throughout the logged interval. Concentrations were measured that ranged between approximately 0.2 pCi/g and 1,800 pCi/g. The maximum concentration was measured at approximately 33 ft.

^{60}Co was detected at 24 and 25 ft with a maximum concentration of approximately 0.3 pCi/g at 25 ft.

^{154}Eu was detected from 23 to 26 ft with a maximum concentration of approximately 11 pCi/g at 24 ft.

Evaluation of the total gamma log indicated that elevated gamma activity observed between 60 and 85 ft does not appear to correlate with either man-made or naturally occurring radionuclides. This led to the suspicion that ^{90}Sr may be present within this interval. Previous experience with logs in the B Tank Farm suggests that the "shape factor" SF2* is useful in detecting zones of bremsstrahlung associated with energetic beta emissions from radionuclides such as ^{90}Sr. SF2* is defined as the quotient of total counts in the 60- to 350-keV energy range divided by total counts in the 350- to 650-keV range (McCain and Koizumi 2002). SF2* has been shown to be about 3.3 to 3.6 in uncontaminated boreholes. In the absence of gamma-emitting radionuclides, SF2* values greater than 4 have been shown to be associated with ^{90}Sr concentrations in excess of 500 pCi/g, and SF2* increases to greater than 6 with increasing ^{90}Sr concentrations. A total gamma / SF2* log was generated for this borehole. Results indicate anomalous values of SF2* between 56 and 86 ft. From these results, it is inferred that ^{90}Sr is present at concentrations greater than 500 to 1,000 pCi/g to a depth of at least 86 ft.

Three distinct zones of contamination are observed in this borehole. The upper zone from 23 to 27 ft consists of ^{137}Cs with ^{60}Co and ^{154}Eu. This zone is separated from the lower two zones by a relatively uncontaminated interval between 27 and 30 ft. Between 30 and 58 ft, ^{137}Cs is present, with a maximum concentration of 1,834 pCi/g at 33 ft. Between 58 and 86 ft, there is no direct evidence of gamma-emitting radionuclides, but anomalous total gamma activity and the behavior of SF2* indicate the presence of ^{90}Sr at concentrations in excess of 1,000 pCi/g. It is possible that ^{90}Sr may also be present at 23 to 27 ft and 30 to

58 ft. Compton scattering from gamma rays associated with ^{137}Cs, ^{60}Co, and ^{154}Eu likely affect SF2*, but the extent of this phenomenon is not well understood.

The plot of the current SGLS total gamma data with historical total gamma data show elevated activity at similar depth locations. The 1963 data show only background gamma activity; the crib was first used in June 1965. The 1970 and 1976 total gamma data suggest relatively long-lived radionuclides (consistent with ^{137}Cs) exist in the sediments between 20 and 60 ft. A gamma peak at approximately 98 ft appears to have decayed significantly by 2005, suggesting radionuclides with relatively short half lives existed at this depth. The historical data also show elevated activity in the vicinity of the groundwater at approximately 310 ft.

The repeat section indicates good agreement of the naturally occurring radionuclides.

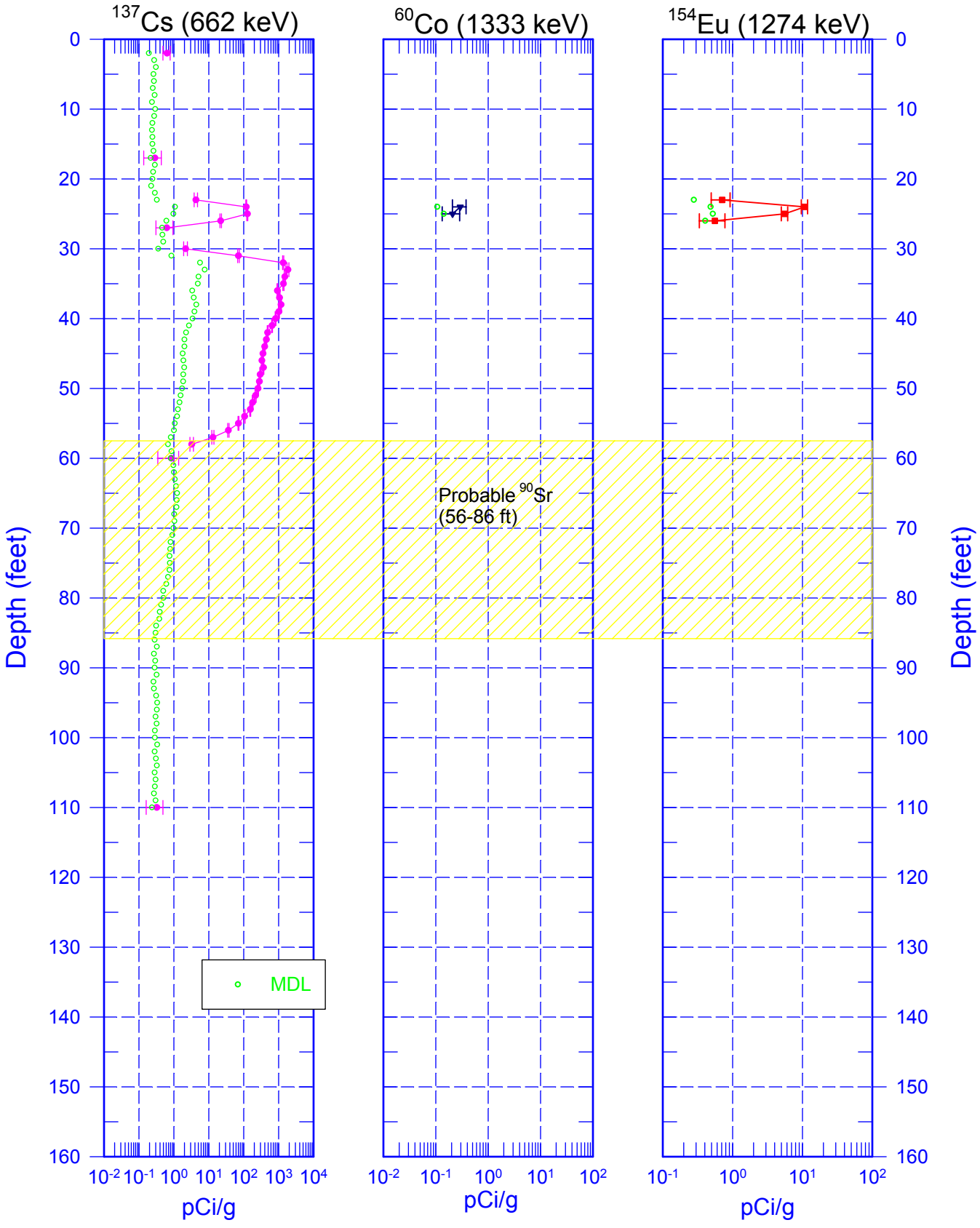
References:

Chamness, M.A., and J.K. Merz, 1993. *Hanford Wells*, PNL-8800, Pacific Northwest Laboratory, Richland, Washington.

McCain, R.G., and C.J. Koizumi, 2002. *Correlation of Spectral Gamma Log Response and Sr-90 Concentrations for a Steel-Cased Borehole*, GJO-2002-322-TAR, prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado.

[1] GWL – groundwater level
[2] N/A – not applicable

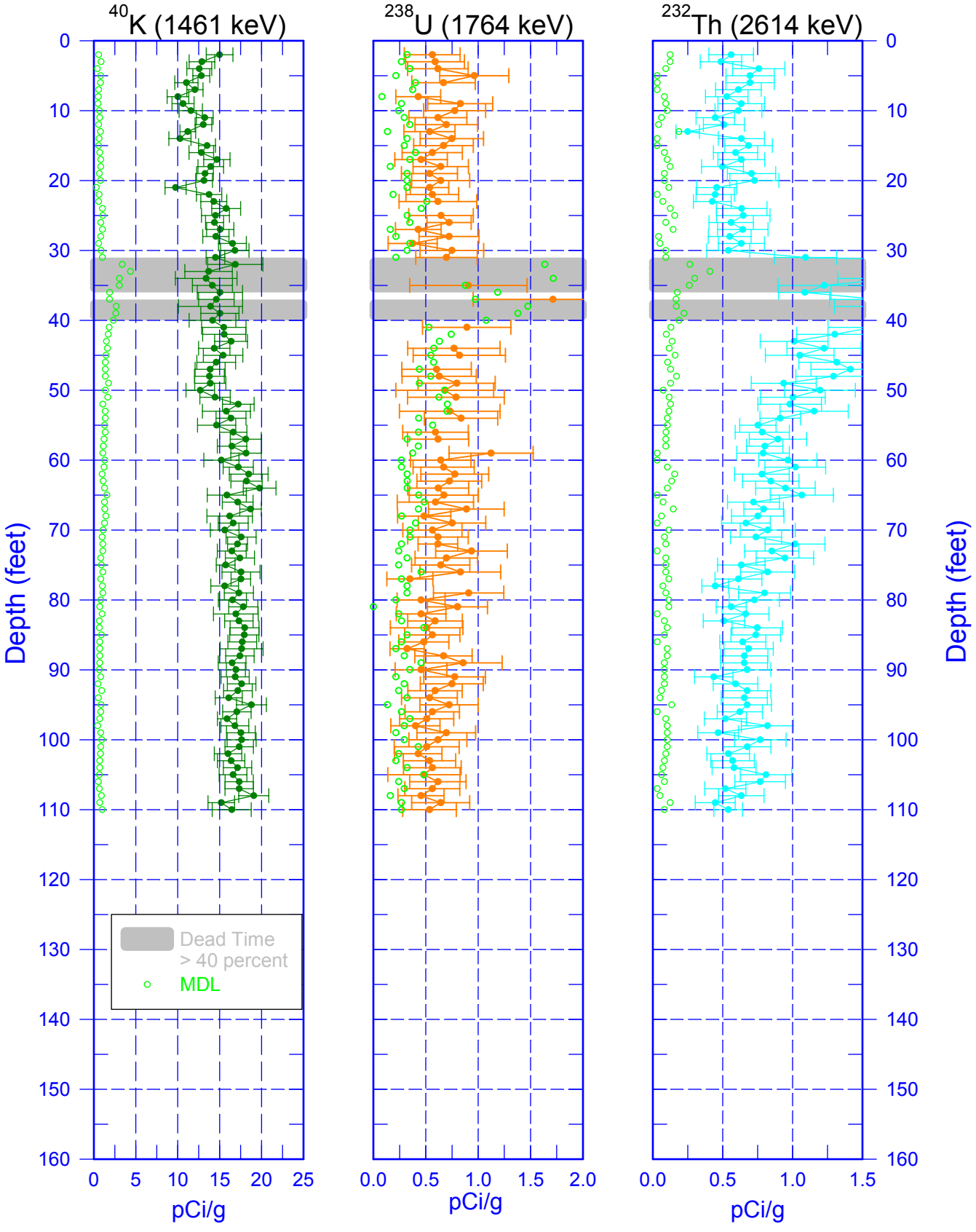
299-E17-02 (A5879)
Man-Made Radionuclides



Zero Reference = Top of Casing

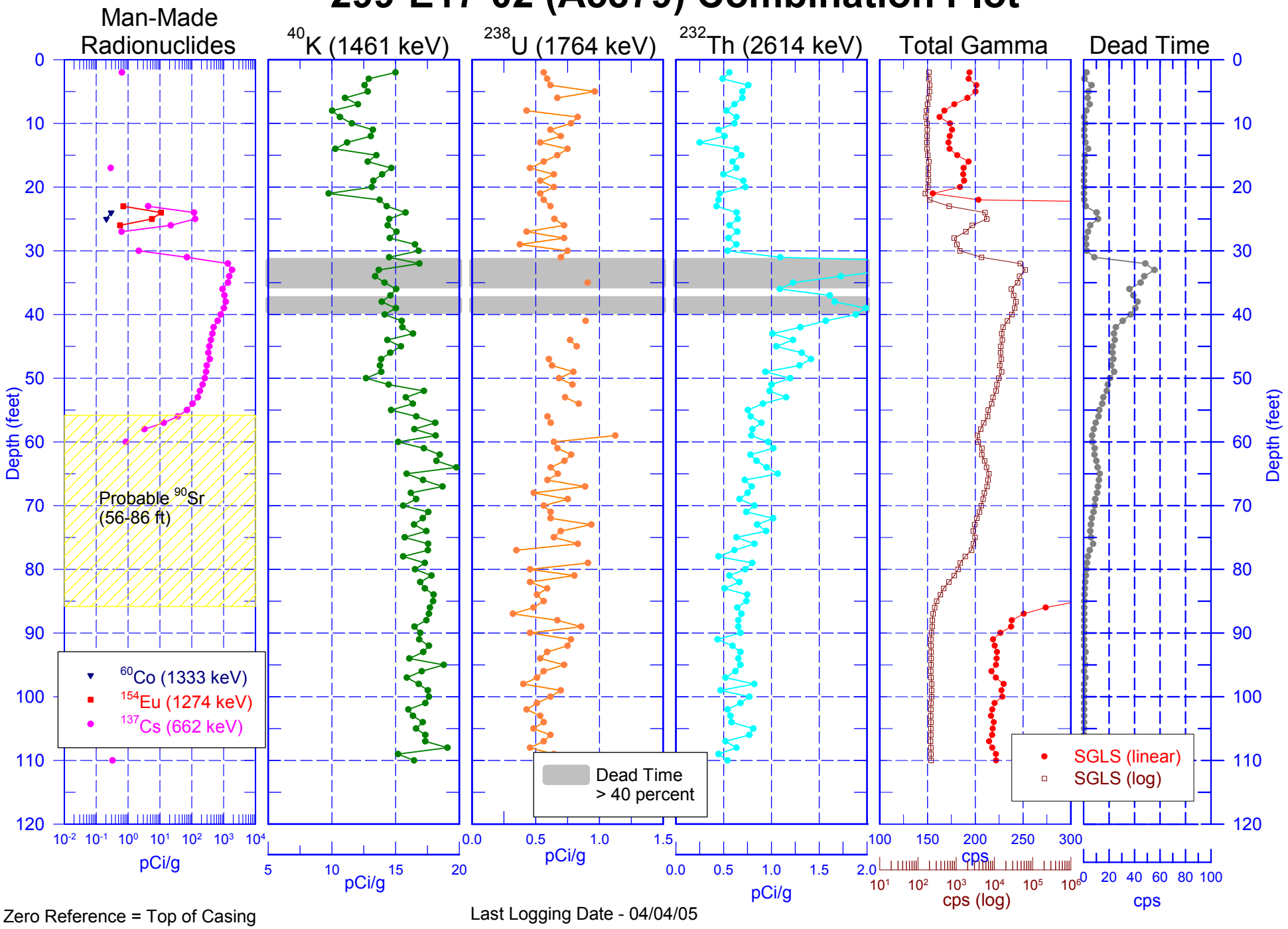
Last Log Date - 04/04/05

299-E17-02 (A5879)
Natural Gamma Logs

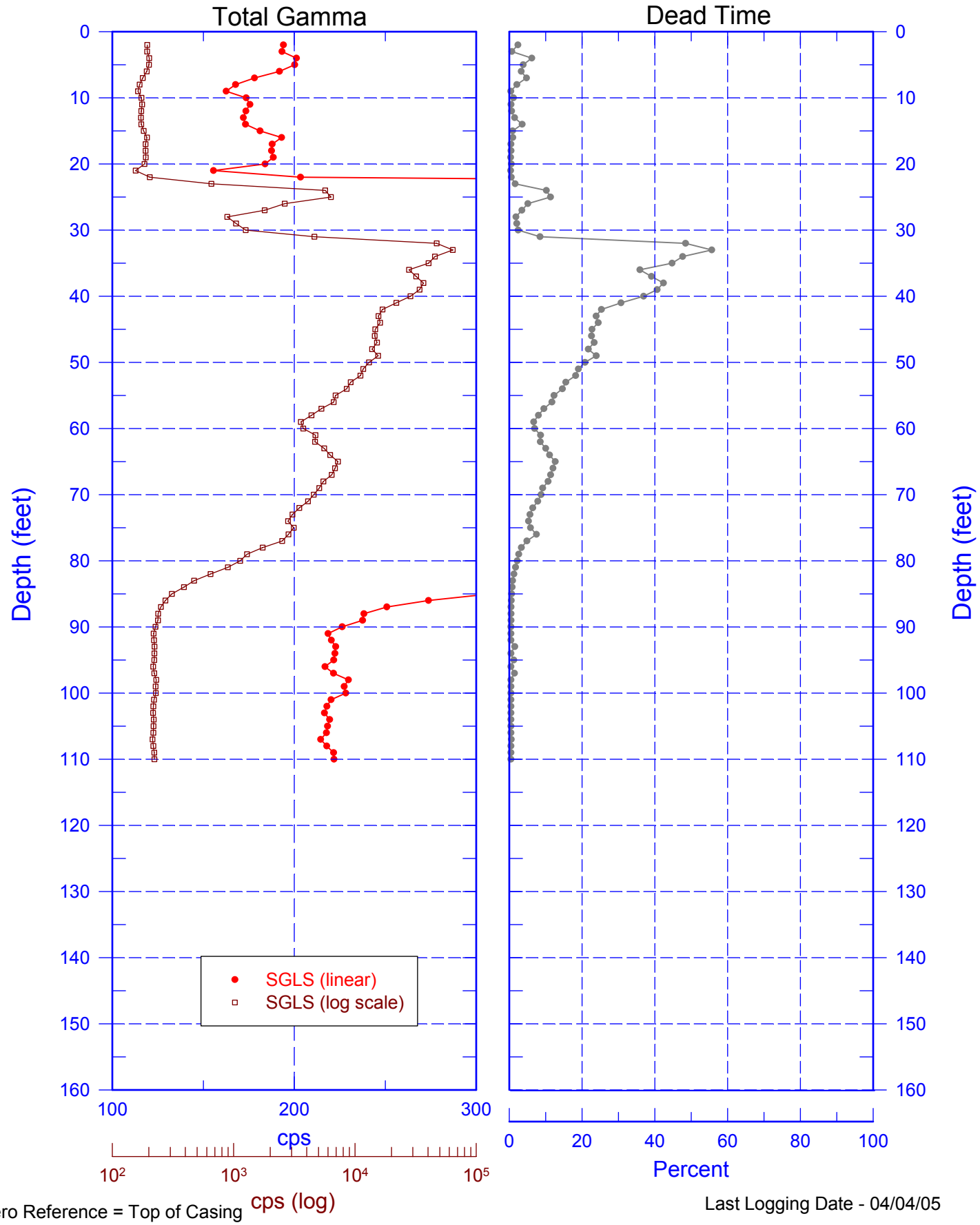


Zero Reference = Top of Casing

Last Log Date - 04/04/05


299-E17-02 (A5879) Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
Probable 90Sr (56-86 ft)
60Co (1333 keV)
154Eu (1274 keV)
137Cs (662 keV)
Dead Time > 40 percent
SGLS (linear)
SGLS (log)
pCi/g
cps
cps (log)
Zero Reference = Top of Casing
Last Logging Date - 04/04/05

299-E17-02 (A5879)
Total Gamma & Dead Time

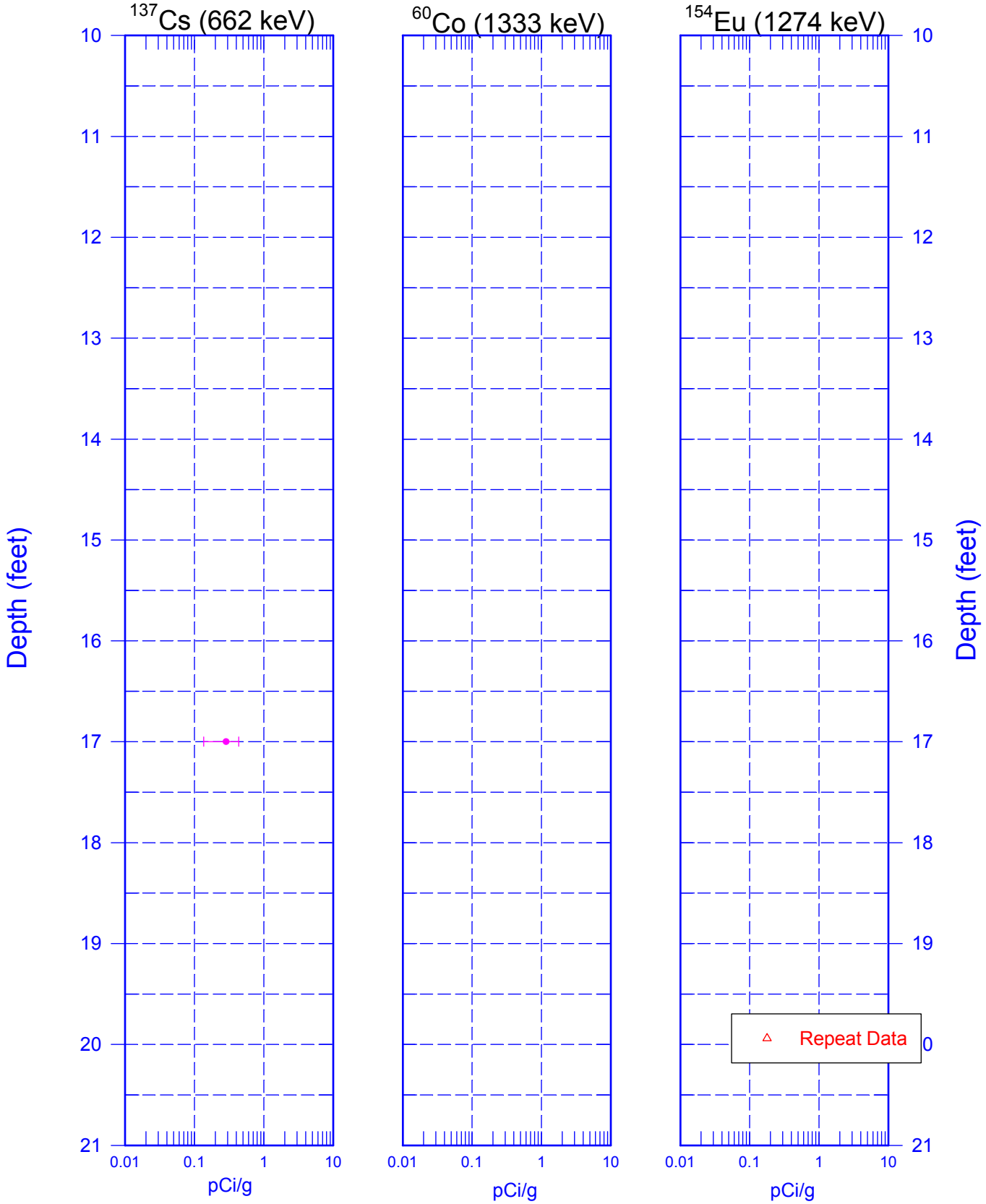


Zero Reference = Top of Casing

Last Logging Date - 04/04/05

299-E17-02 (A5879)

Repeat Section of Man-Made Radionuclides

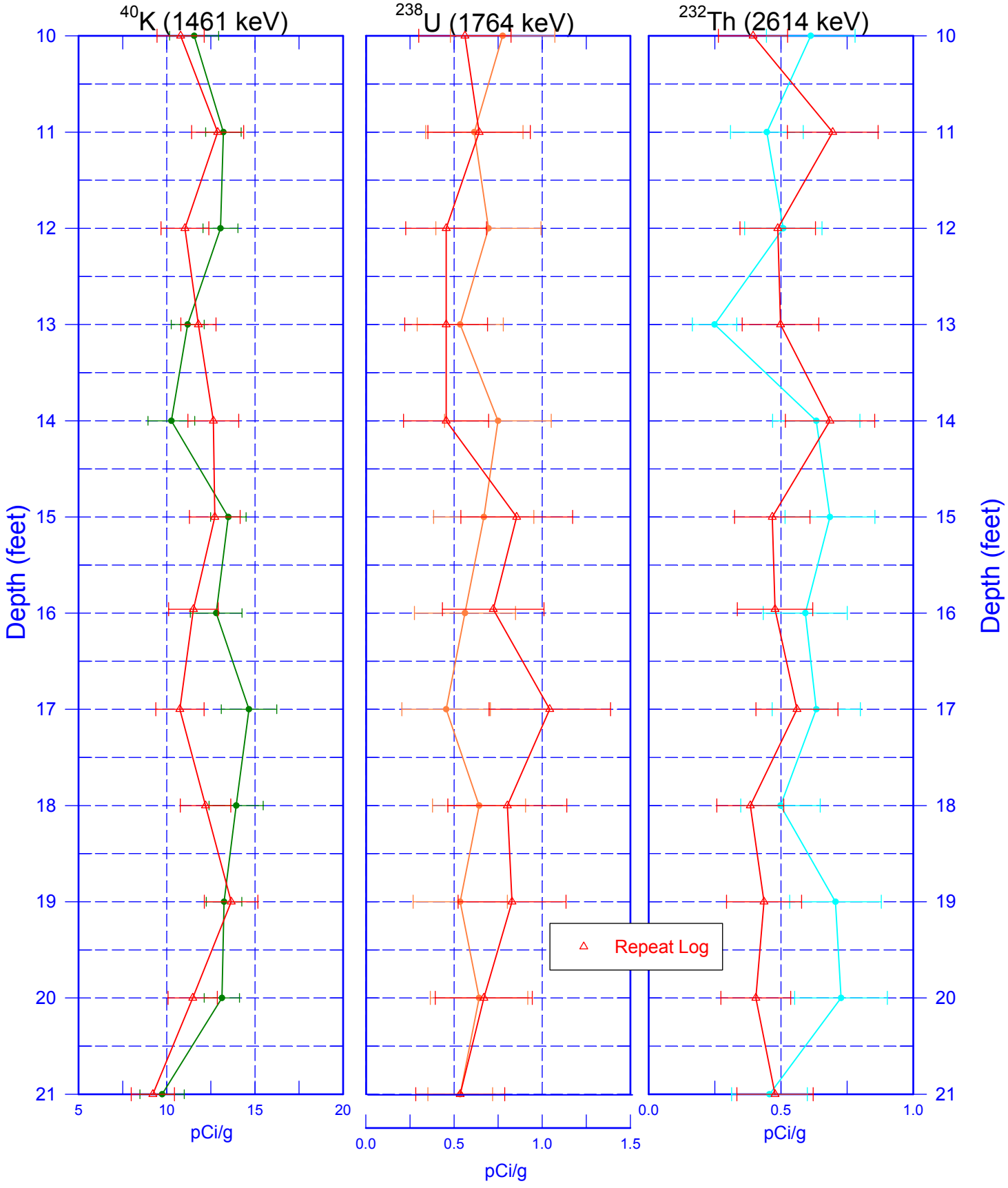


Zero Reference = Top of Casing

Last Log Date - 04/04/05

299-E17-02 (A5879)

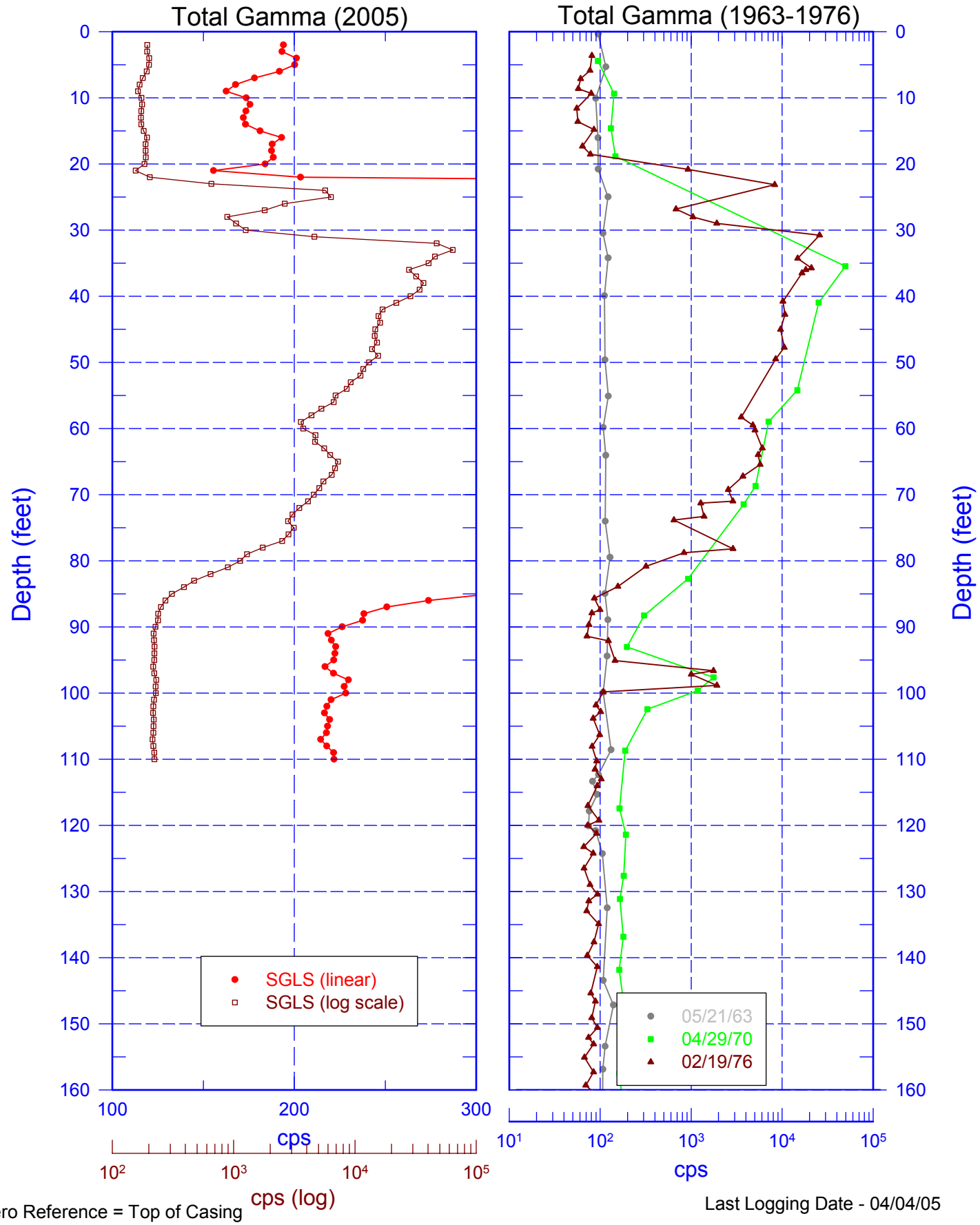
Repeat Section of Natural Gamma Logs



Zero Reference = Top of Casing

Last Log Date - 04/04/05

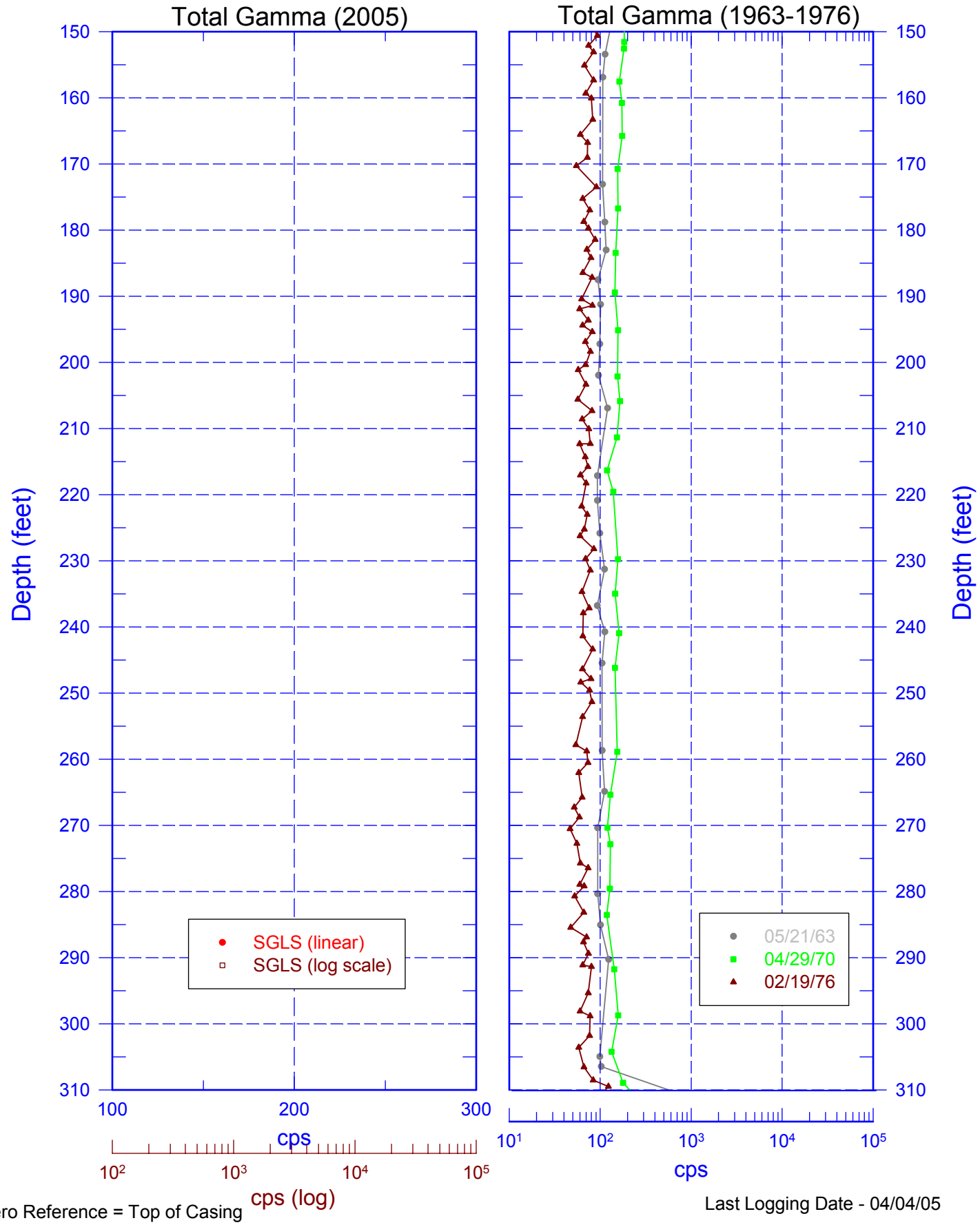
299-E17-02 (A5879)
Total Gamma Logs



Zero Reference = Top of Casing

Last Logging Date - 04/04/05

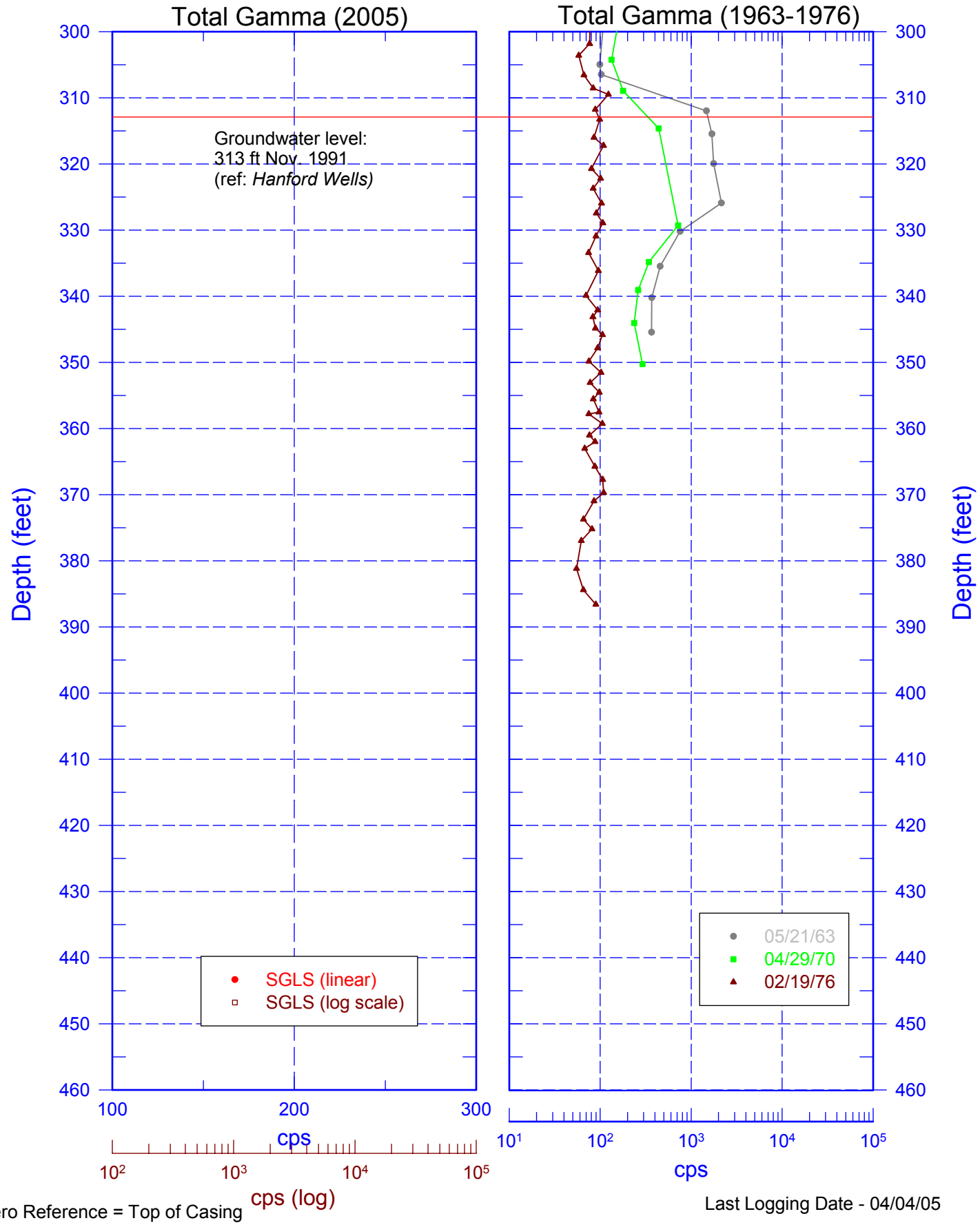
299-E17-02 (A5879)
Total Gamma Logs



Zero Reference = Top of Casing

Last Logging Date - 04/04/05

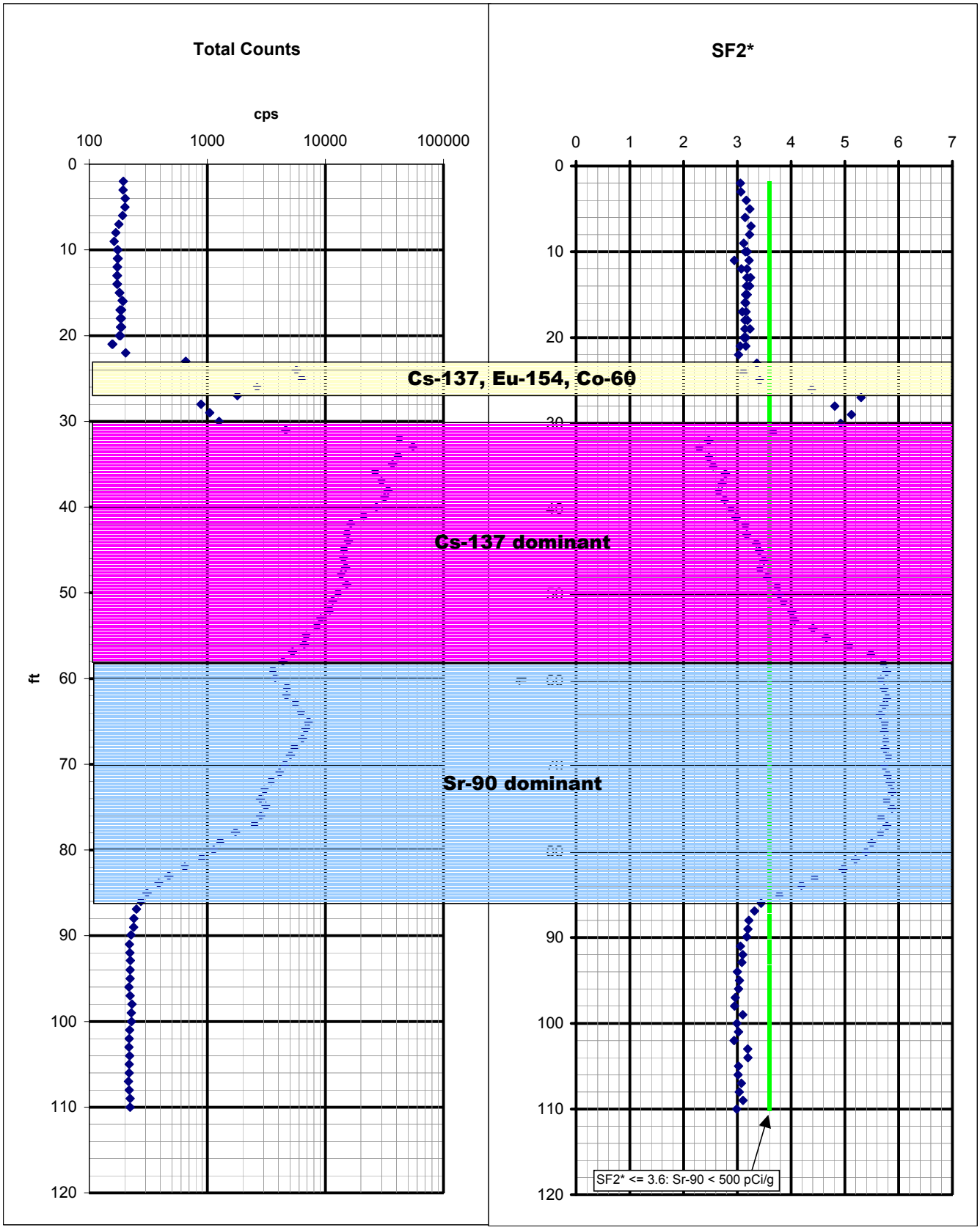
299-E17-02 (A5879)
Total Gamma Logs



Zero Reference = Top of Casing

Last Logging Date - 04/04/05

299-E17-02


Total Counts
SF2*
cps
100
1000
10000
100000
0
1
2
3
4
5
6
7
ft
0
10
20
30
40
50
60
70
80
90
100
110
120
Cs-137, Eu-154, Co-60
Cs-137 dominant
Sr-90 dominant
SF2* <= 3.6: Sr-90 < 500 pCi/g